

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7W53FU, TC7W53FK

## 1. Functional Description

2-Channel Multiplexer/Demultiplexer

## 2. General

The TC7W53 is a high speed C<sup>2</sup>MOS Analog Multiplexer/Demultiplexer fabricated with silicon gate C<sup>2</sup>MOS technology. It achieves the high speed operation similar to equivalent LSTTL while maintaining the C<sup>2</sup>MOS low power dissipation.

The TC7W53 has a 2 channel configuration.

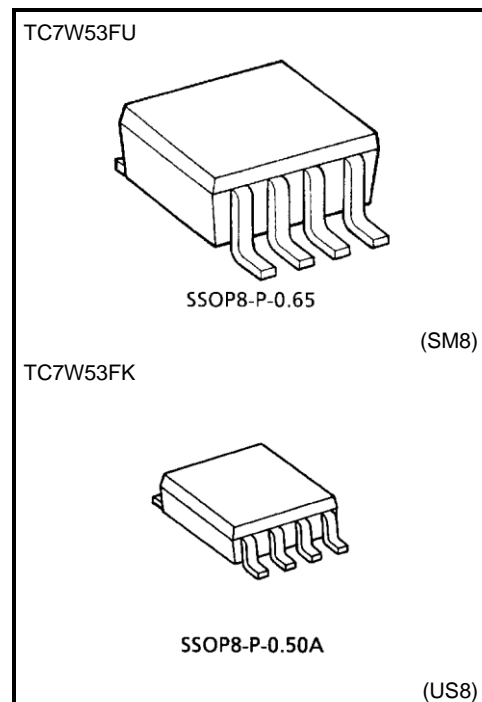
The digital signal to the control terminal turns "ON" the corresponding switch of each channel a large amplitude signal ( $V_{CC} - V_{EE}$ ) can then be switched by the small logical amplitude ( $V_{CC} - GND$ ) control signal.

For example, in the case of  $V_{CC} = 5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $V_{EE} = -5\text{ V}$ , signals between  $-5\text{ V}$  and  $+5\text{ V}$  can be switched from the logical circuit with a signal power supply of  $5\text{ V}$ . As the ON-resistance of each switch is low, they can be connected to circuit with low input impedance.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

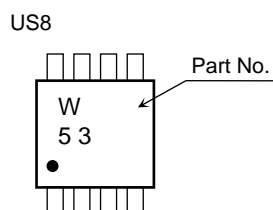
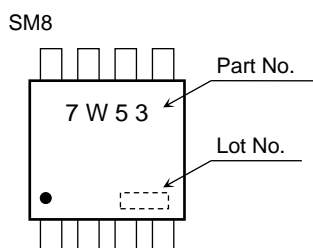
## 3. Features

- High speed:  $t_{pd} = 15\text{ ns}$  (typ.) at  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$
- Low power dissipation:  $I_{CC} = 4\text{ }\mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Low ON resistance:  $R_{ON} = 50\text{ }\Omega$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- High degree of linearity:  $THD = 0.02\%$  (typ.) at  $V_{CC} - V_{EE} = 9\text{ V}$
- Pin and function compatible with TC4W53



Weight  
 SSOP8-P-0.65: 0.02 g (typ.)  
 SSOP8-P-0.50A: 0.01 g (typ.)

## 4. Marking



Start of commercial production  
 1997-12

### 5. Absolute Maximum Ratings (Ta = 25°C) (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V <sub>CC</sub>	-0.5 to 7	V
	V <sub>CC</sub> - V <sub>EE</sub>	-0.5 to 13	
Control input voltage	V <sub>IN</sub>	-0.5 to V <sub>CC</sub> + 0.5	V
Switch I/O voltage	V <sub>I/O</sub>	V <sub>EE</sub> - 0.5 to V <sub>CC</sub> + 0.5	V
Control input diode current	I <sub>CK</sub>	±20	mA
I/O diode current	I <sub>I/O</sub>	±20	mA
Switch through current	I <sub>T</sub>	±25	mA
DC V <sub>CC</sub> /GND current	I <sub>CC</sub>	±25	mA
Power dissipation	P <sub>D</sub>	300 (SM8)	mW
		200 (US8)	
Storage temperature range	T <sub>stg</sub>	-65 to 150	°C
Lead temperature (10 s)	T <sub>L</sub>	260	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

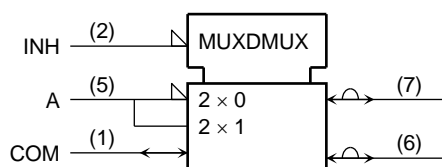
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

### 6. Truth Table

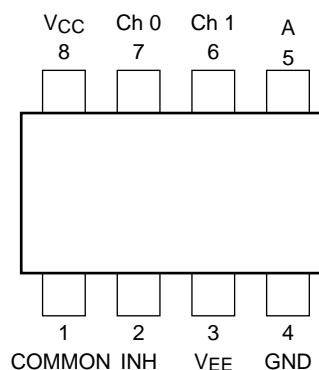
Control Input		On Channel
INH	A	
L	L	Ch 0
L	H	Ch 1
H	X	None

X: Don't care

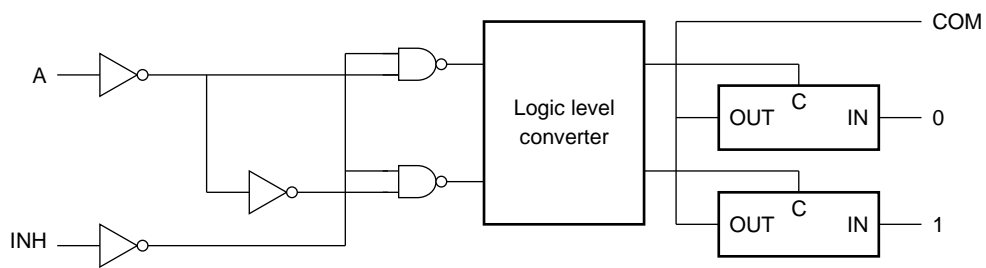
### 7. Logic Symbol



### 8. Pin Assignment (top view)



## 9. Logic Diagram



## 10. Operating Ranges

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2 to 6	V
	$V_{EE}$	-6 to 0	
	$V_{CC} - V_{EE}$	2 to 12	
Control input voltage	$V_{IN}$	0 to $V_{CC}$	V
Switch I/O voltage	$V_{I/O}$	$V_{EE}$ to $V_{CC}$	V
Operating temperature range	$T_{opr}$	-40 to 85	°C
Input rise and fall time	$t_r, t_f$	0 to 1000 ( $V_{CC} = 2.0$ V)	ns
		0 to 500 ( $V_{CC} = 4.5$ V)	
		0 to 400 ( $V_{CC} = 6.0$ V)	

### 11. Electrical Characteristics

#### DC Electrical Characteristics

Characteristics		Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit		
				V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Min	Typ.	Max		Min	Max
Control input voltage	High level	V <sub>IHC</sub>	—	—	2.0	1.5	—	—	1.5	V	
				—	4.5	3.15	—	—	3.15		—
				—	6.0	4.2	—	—	4.2		—
	Low level	V <sub>ILC</sub>	—	—	2.0	—	—	0.5	—		0.5
				—	4.5	—	—	1.35	—		1.35
				—	6.0	—	—	1.8	—		1.8
ON resistance	RON	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> ≤ 2 mA	GND	4.5	—	85	180	—	225	Ω	
			-4.5	4.5	—	55	120	—	150		
			-6.0	6.0	—	50	100	—	125		
			GND	2.0	—	150	—	—	—		—
			GND	4.5	—	70	150	—	190		—
			-4.5	4.5	—	50	100	—	125		—
Difference of ON resistance between switches	ΔRON	V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub> V <sub>I/O</sub> = V <sub>CC</sub> to V <sub>EE</sub> I <sub>I/O</sub> ≤ 2 mA	GND	4.5	—	10	30	—	35	Ω	
			-4.5	4.5	—	5	12	—	15		
			-6.0	6.0	—	5	10	—	12		
Input/output leakage current (switch off)	I <sub>OFF</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IS</sub> = GND to V <sub>CC</sub> V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	6.0	—	—	±60	—	±600	nA	
			-6.0	6.0	—	—	±100	—	±1000		
Switch input leakage current (switch on output open)	I <sub>Iz</sub>	V <sub>OS</sub> = V <sub>CC</sub> or GND V <sub>IN</sub> = V <sub>ILC</sub> or V <sub>IHC</sub>	GND	6.0	—	—	±60	—	±600	nA	
			-6.0	6.0	—	—	±100	—	±1000		
Control input current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND	6.0	—	—	±0.1	—	±1.0	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	GND	6.0	—	—	4	—	40	μA	
			-6.0	6.0	—	—	8	—	80		

### AC Electrical Characteristics ( $C_L = 50 \text{ pF}$ , input $t_r = t_f = 6 \text{ ns}$ , $GND = 0 \text{ V}$ )

Characteristics	Symbol	Test Condition	$T_a = 25^\circ\text{C}$			$T_a = -40$ to $85^\circ\text{C}$		Unit		
			$V_{EE}$ (V)	$V_{CC}$ (V)	Min	Typ.	Max		Min	Max
Phase difference between input and output	$\phi/I/O$	—	GND	2.0	—	25	60	—	75	ns
			GND	4.5	—	6	12	—	15	
			GND	6.0	—	5	10	—	13	
			-4.5	4.5	—	4	—	—	—	
Output enable time	$t_{pZL}$ $t_{pZH}$	$R_L = 1 \text{ k}\Omega$	GND	2.0	—	50	225	—	280	ns
			GND	4.5	—	14	45	—	56	
			GND	6.0	—	12	38	—	48	
			-4.5	4.5	—	14	—	—	—	
Output disable time	$t_{pLZ}$ $t_{pHZ}$	$R_L = 1 \text{ k}\Omega$	GND	2.0	—	95	225	—	280	ns
			GND	4.5	—	30	45	—	56	
			GND	6.0	—	26	38	—	48	
			-4.5	4.5	—	26	—	—	—	
Control input capacitance	$C_{IN}$	—	—	—	—	5	10	—	10	pF
Common terminal capacitance	$C_{IS}$	—	-5.0	5.0	—	11	20	—	20	pF
Switch terminal capacitance	$C_{OS}$	—	-5.0	5.0	—	7	15	—	15	pF
Feed through capacitance	$C_{IOS}$	—	-5.0	5.0	—	0.75	2	—	2	pF
Power dissipation capacitance	CPD	(Note 1)	GND	5.0	—	67	—	—	—	pF

Note 1: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:  $I_{CC}(\text{opr}) = CPD \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$

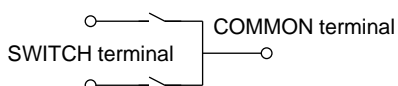
### Analog Switch Characteristics (Note) (GND = 0 V, Ta = 25°C)

Characteristics	Symbol	Test Condition		V <sub>EE</sub> (V)	V <sub>CC</sub> (V)	Typ.	Unit
Sine wave distortion (T.H.D)	—	R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 kHz	V <sub>IN</sub> = 4.0 Vp-p	-2.25	2.25	0.025	%
			V <sub>IN</sub> = 8.0 Vp-p	-4.5	4.5	0.02	
			V <sub>IN</sub> = 11 Vp-p	-6.0	6.0	0.018	
Frequency response (switch ON)	t <sub>MAX</sub>	Adjust V <sub>IN</sub> voltage to obtain 0 dBm at V <sub>OS</sub> Increase F <sub>IN</sub> until dB Meter reads -3 dB R <sub>L</sub> = 50 Ω, C <sub>L</sub> = 10 pF f <sub>IN</sub> = 1 MHz, sine wave	(Note1)	-2.25	2.5	120	MHz
			(Note2)			95	
			(Note1)	-4.5	4.5	190	
			(Note2)			150	
			(Note1)	-6.0	6.0	200	
			(Note2)			190	
Feed Through attenuation (switch OFF)	—	V <sub>IN</sub> is centered at (V <sub>CC</sub> -V <sub>EE</sub> )/2. Adjust input for 0 dBm R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 MHz, sine wave		-2.25	2.25	-50	dB
				-4.5	4.5	-50	
				-6.0	6.0	-50	
Crosstalk (control input to signal output)	—	R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 MHz, square wave (t <sub>r</sub> = t <sub>f</sub> = 6 ns)		-2.25	2.25	60	mV
				-4.5	4.5	140	
				-6.0	6.0	200	
Crosstalk (between any switches)	—	Adjust V <sub>IN</sub> to obtain 0 dBm at input R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 50 pF f <sub>IN</sub> = 1 MHz, sine wave		-2.25	2.25	-50	dB
				-4.5	4.5	-50	
				-6.0	6.0	-50	

Note: These characteristics are determined by design of device.

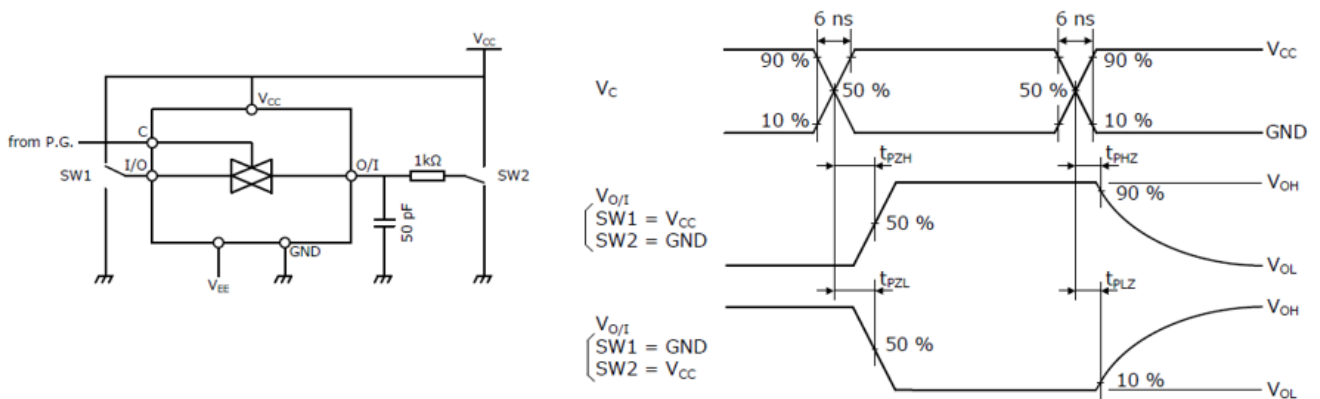
Note 1: Input COMMON terminal, and measure at SWITCH terminal.

Note 2: Input SWITCH terminal, and measure at COMMON terminal.



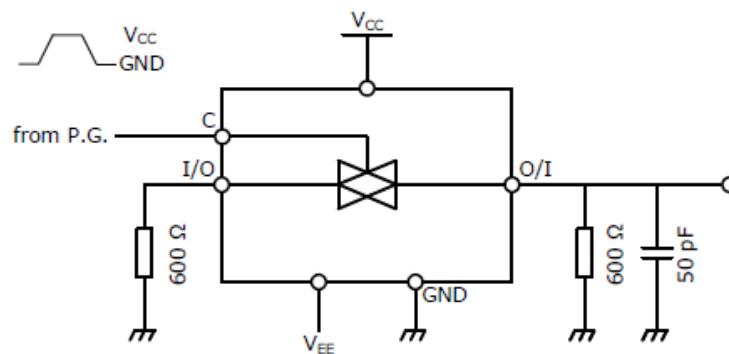
### 12. Switching Characteristics Test Circuits

#### 1. $t_{pLZ}$ , $t_{pHZ}$ , $t_{pZL}$ and $t_{pZH}$

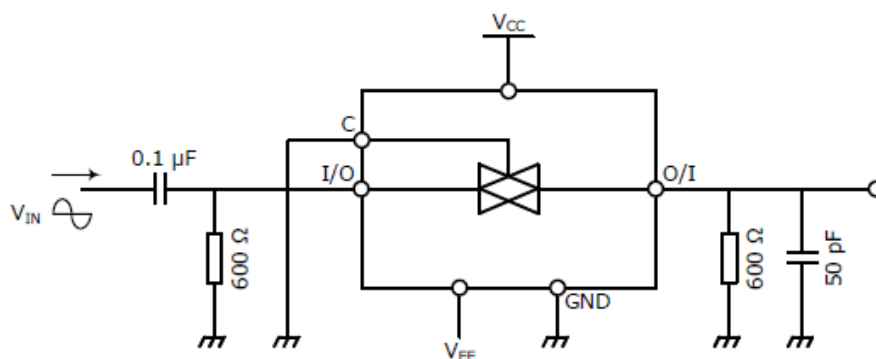


#### 2. Cross Talk (control input-switch output)

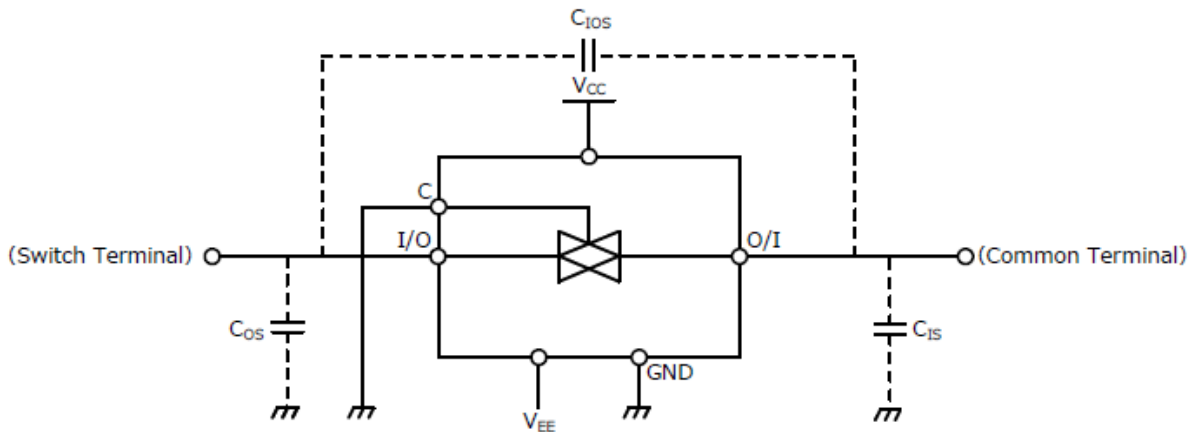
$f_{IN} = 1 \text{ MHz}$ , duty = 50% and  $t_r = t_f = 6 \text{ ns}$



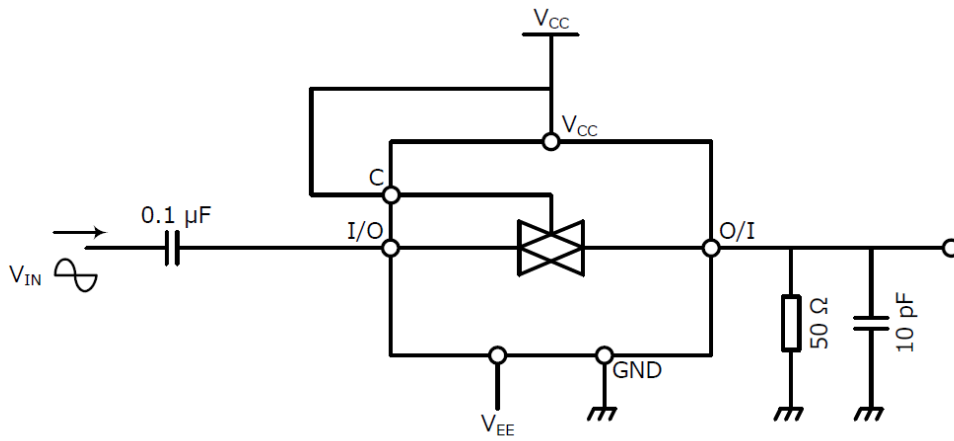
#### 3. Feed Through Attenuation



## 4. C<sub>IOS</sub>, C<sub>IS</sub>, C<sub>OS</sub>



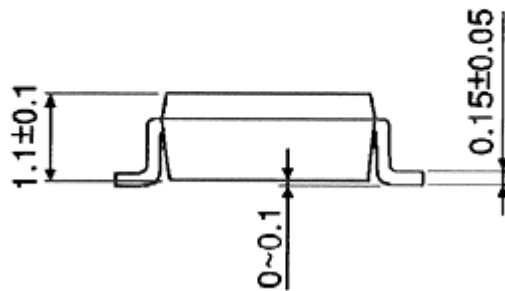
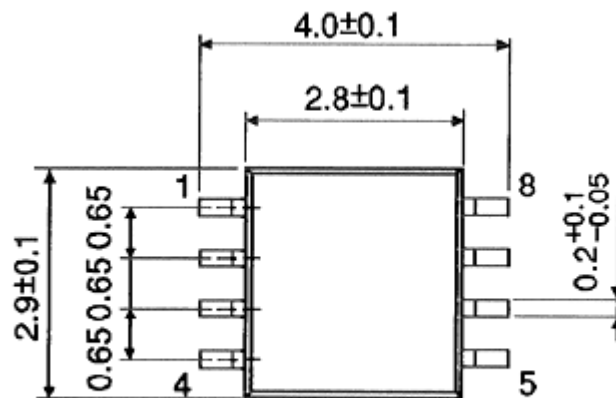
## 5. Frequency Response (switch ON)



### Package Dimensions

SSOP8-P-0.65

Unit : mm

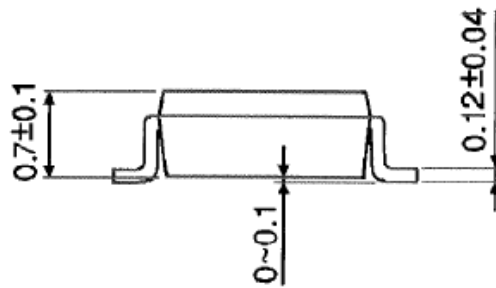
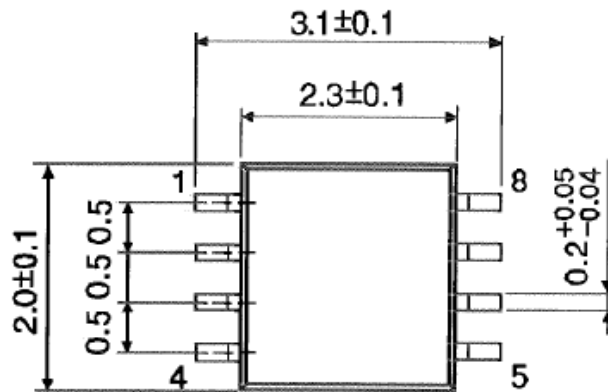


Weight: 0.02 g (typ.)

### Package Dimensions

SSOP8-P-0.50A

Unit : mm



Weight: 0.01 g (typ.)

## RESTRICTIONS ON PRODUCT USE

Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as "TOSHIBA". Hardware, software and systems described in this document are collectively referred to as "Product".

- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, Class 3 medical devices, equipment used for automobiles, and military vehicles and munitions. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**